Asteroid Surface Resource Characterization through Distributed Plasma Analysis of Meteoroid Impact Ejecta

Completed Technology Project (2015 - 2018)

Project Introduction

Meteoroids comprising the sporadic background population continuously impact larger bodies in the solar system at high speeds. In particular, asteroids are subjected to hypervelocity impacts on their surface due to the lack of atmosphere, resulting in the formation of ejecta plasma. Based on interplanetary meteoroid flux models, a 1 km asteroid at 1 AU would encounter over 100,000 impacts per day from meteoroids larger than 1 nanogram (10 micrometers). This plasma is primarily composed of ionized material from the asteroid surface with only a small contribution from the impacting meteoroid (estimated to be 2% based on crater volume models), and provides a mechanism for characterizing the surface composition of the asteroid. We propose to develop a low mass and low power sensor concept to complement the spectroscopic analysis of an asteroid's surface composition by studying the transient plasma environment in its vicinity. This concept would enable rapid coverage of the asteroid surface using a cluster of nano- or picosatellites equipped with plasma sensors. As humans start to exploit the natural resources available on asteroids, the initial cost will be quite high. Accordingly, it will be necessary to demonstrate that resource extraction missions are targeted at sites of high return. This will likely involve lower-cost precursor missions to several potential asteroids before sending a mining or redirect spacecraft to the one with the most value. The concept presented here enables measurements to be made using multiple (on the order of 10 to 100) identical small spacecraft, and provides a greater coverage of the asteroid surface than with a single conventional spacecraft using more traditional instruments. The use of multiple spacecraft in a cluster provides a dramatic increase in the robustness of the system to single failures, with a gradual decrease in performance rather than complete loss of a particular capability. The plasma sensor is based on the concept of mass spectroscopy, which would provide a measurement of the asteroidal molecular composition rather than the atomic composition as measured through IR, X-ray, or gamma-ray spectroscopy.

Anticipated Benefits

This work aims to develop a low mass and low power sensor concept to complement the spectroscopic analysis of an asteroid's surface composition by studying the transient plasma environment in its vicinity. In support of potential human exploitation of the natural resources, this concept could enable rapid coverage of the asteroid surface using a cluster of nano- or picosatellites equipped with plasma sensors.

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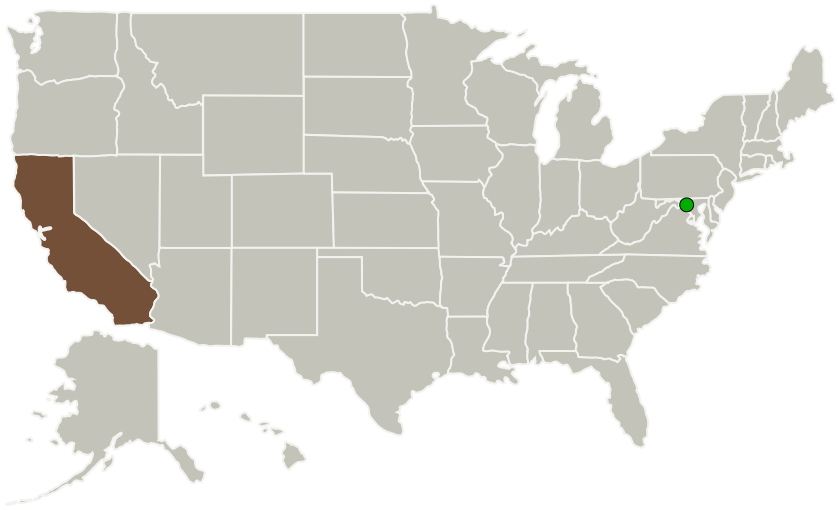
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Stanford University(Stanford)	Lead Organization	Academia	Stanford, California
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
California

Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Stanford University (Stanford)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

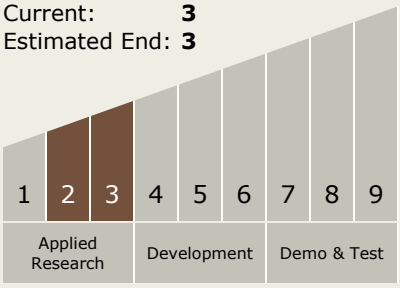
Hung D Nguyen

Principal Investigator:

Sigrid Close

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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Technology Areas

Primary:

- TX07 Exploration Destination Systems
  - TX07.1 In-Situ Resource Utilization
    - TX07.1.1 Destination Reconnaissance and Resource Assessment

Target Destination

Others Inside the Solar System